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Discussions

Interactive comment on "Towards a monitoring system of temperature extremes in Europe" *by* Christophe Lavaysse et al.

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Towards a monitoring system of temperature extremes in Europe Christophe Lavaysse, Carmelo Cammalleri, Alessandro Dosio, Gerard van der Schrier, Andrea Toreti and Jürgen Vogt

Review 1: General comments: This is an interesting work, with an interdisciplinary (climate vs health sciences) view, including a reach bibliography in this sense, that fits very well in NHESS and can serve as a reference in discussing concepts like the definition of a heat and cold wave. Nevertheless, I would ask for some clarifications regarding concepts and also for several corrections before final publications. The authors recognise the need of including a reference to human health effects in the definition and intensity

determination of heat and cold waves, following WMO recommendations and previous authors statements. In this sense they indicate that the effects on human health can be more related with absolute thermal extremes than to climatological anomalies, but all the work they have done is regarding climatological anomalies, not absolute extremes. The authors are mentioning that the third index of intensity they propose (I3) is oriented to absolute extremes, but I think this is not totally true: the seasonal component of the anomaly (that is clearly influencing both the detection and the I2 intensity) is removed with I3, but no the effect of the geographical, climatic or latitudinal conditioning is not. The reference to calculate differences is always place depending; it depends of the grid point climate, even when the seasonal average is considered to define the reference. I3, for instance, is more measuring the climatological rarity than a risk for the human health, unless the risk for human health is as much depending of the climatological rarity than of the absolute extreme values. In other words, is a summer temperature of 30 degrees in Lapland as much dangerous for human health as 45 degrees in southern Iberia? More clarity about this question would be appropriate in this work, which area of study is geographically/climatologically quite large.

First, we would like to thank the anonymous reviewer for the complete and fruitful review.

We partially agree with the first comment: That is true the intensity (I3) is still dependent on the climatology and therefore also on the geographical location. The only way to avoid this would be to apply a constant threshold such as 35 or 40 degrees for heat waves and -10 or -20 degrees for cold waves across the entire continent. These definitions are relatively easy to understand due to the potential impacts linked to such extreme temperatures. Nevertheless, this choice could also be criticised. For example, the heat wave in France in 2003 was associated with absolute temperatures close to 40 degrees. These temperatures are, however, regularly overpassed in Spain (46.8 degrees this year in Cordoba) and are relatively closer to the climatology for Southern

Spain, so the impacts are expected to be different for the same absolute temperature. In other words, the impact of heat or cold waves depends also on the societal adaptation, on the available infrastructures (e.g. air conditioning, building insulations), and so on the climatology. For these reasons it is difficult to define the most robust indicator (if it exists at all).
In this study we have, therefore, chosen indicators based on the rarity of the events. The assumption behind this choice is that the lack of adaptation to these rare events will increase their impacts and so this rarity is representing a potential risk. This point will be discussed in the new version of the paper.

Specific comments/corrections: -(Lines 110-113) Are six month periods short enough to be considered as summer/winter events?

The heat and cold waves are calculated during the entire year. However, information on heat waves (cold waves) is provided only in the summer (winter) months as defined. We have chosen to decompose the year into two extended seasons to simplify the message. Nevertheless, the calculation of the heat (cold) waves for the human health impacts (I3) takes into account the seasonal peak (bottom respectively) of temperature and so favours the waves occurring during the core of the season.

-(Lines 117-118) Is the 11 days' window only used in constructing the calendar of maximum and minimum temperatures?

As mentioned in the text, the 11-day windows are only used to increase the sampling when the CDF of temperature is generated for the quantile calculation.

-(Lines 135-136) It seems that the only pool accepted within a heat/cold wave is a one-day pool, then the word "less" is not appropriate.

Modified as suggested.

-(Lines 145-150 and tables 1 and 2) The numbers in the tables seem to be space mean/average values. Are they total or time mean/average values (per year?), referred

to the 21 years'period? 17 heat waves and 25 cold waves per year, in every grid point, on spatial and time average, seem to be many waves. Around one per year, only, seems to be a small number. The number of hot and cold days' forces to think in the second interpretation. In addition, regarding hot and cold days we can hope equal number of days within the extremes percentiles (0.9 and 0.1, respectively) for Tmin and Tmax. This is the case for cold days, but not for hot days: why not?

The captions of the tables are now clarified. Here, the spatial mean occurrence of waves during the entire period is plotted (i.e. the second interpretation of the reviewer is correct). The number could be interpreted as small, but the objective of the study is to focus on the most extreme events that are, by definition, limited. Also there is a spatial variability of the frequency of occurrence as shown Fig. 4 or Fig. 5, and these occurrences are sometimes larger than 30 (40) for the heat (cold) waves.
The reviewer is right about the constant hot and cold days using only Tmin and Tmax. Nevertheless, two effects will influence the results:

- the presence of undefined values that modify the sampling size
- temperature (quantile) values equal to the thresholds

That occurs both in summer and winter. In winter, by 'chance' the samples are equal to the first percentile of the total population; nevertheless, the standard deviations, which are different to zero, indicate the presence of the same artefact in all cases.

-(Line 156) Are 0.9 and 0.1 the only possible values for Thres?

As discussed in the introduction section, these values are the most common used in the literature and allow to detect enough extreme events to perform statistics. In a previous version of this work other thresholds were chosen. The number of events are, of course, strongly influenced. But most of the spatial variabilities and the coherence between the different datasets are retained.

-(Lines 156, 164, 172) Does N include the pool day, if any?

No, as discussed in the chapter (l136-137), the pool day is not taken into account in the calculation of the intensity. This sentence has been clarified.

-(Line 235) I don't understand the first sentence

The sentence was rephrased. The meaning of this sentence is to introduce the mean duration of the waves.

-(Lines 241-243) There is here a coherent explanation for an experimental result, but it is a quite surprising assessment for me: it is supposed that the oceans are stabilising factors for the temperature, reducing the variability (?)

That is a good point. Our hypothesis about the increase of duration close to the Baltic Sea is based on the the oceans' stabilizing effect on the temperature and therefore a signal with lower high frequency modulations. In this case, if an anomaly occurs, it has a bigger chance to be longer and so potentially creates longer heat/cold waves. This is due to our detection method of HW and CW that is based on the quantiles and not on absolute temperature. The latter is generally less variable and less extreme along the coasts. To illustrate this behavior, the wavelet analysis (Torence and Compo, 1998) of temperature in winter and summer is calculated. To focus on the high frequency variabilities, the power of the Lorentz boxes with periodicity lower than 3 days are summed up. Regions with large (low) high frequency modulations are indicated with large (low) power. This method is quite close to a classical FFT, but it is more powerful with information in both time and frequency. In the Fig. 1, the regions with low modulations (Eastern Europe in summer or Northern Russia and north of Poland in winter) are also the regions with high frequency of occurrence or with longer durations.

-(Lines 271-286 and figures 9 and 10) The problem with the 2003 summer in south-western Europe was the repetition of hot events in the same summer, perhaps not all of them strictly fitting the heat wave definition, but with a dangerous accumulative effect.

When taking only one of the events (the strongest heat wave) appears France with a role that perhaps is not very realistic. Perhaps the sum of intensities in the year of larger sum could be a complement or a substitution for the results shown ...(?)

As explained in the paper, the operational system will sum up all the intensities of heat/cold waves that occurred during the last month, the last couple of months and the entire season. The purpose is exactly to fulfil the characteristic mentioned by the reviewer to take into account the repetition of several events in a row. This will be implemented operationally and the time span considered depends on the month. Table 3 indicates for each month which indicator will be calculated.

-(Table 3) I don't understand this table well. Would you like to be more clear?

Please see the previous comment. The caption of the table has been changed to clarify it.

-(Figure 7) It seems to me that the squares c) and d) are exchanged

No, square c is for the comparison in between I1 and I2 in winter.

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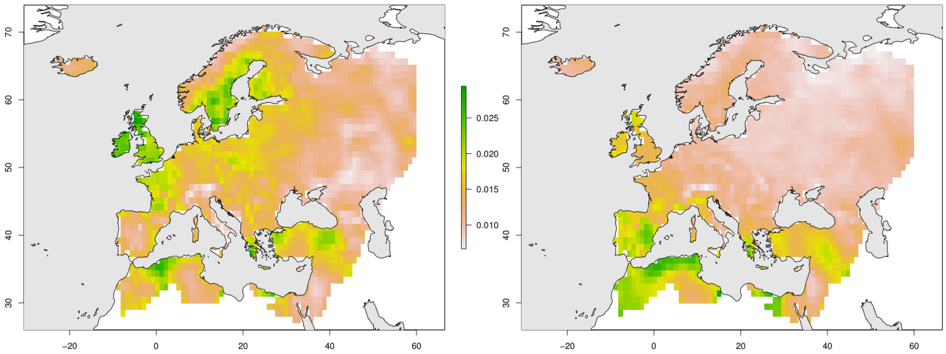

Fig. 1. Sum of the power of Lorenz boxes (with periodicity lower than 3 days) of the wavelet analysis of the merged Tmin and Tmax, in summer (left) and in winter (right).